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GRAYLING MIGRATION AND HABITAT

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STATE OF ALASKA

Bill Sheffield, Governor

Annual Performance Report for

POPULATION STRUCTURE AND DYNAMICS OF THE ARCTIC GRAYLING, WITH EMPHASIS ON HEAVILY FISHED STOCKS

By

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Job No.: R-I-A Job Title: Population Structure and Dynamics of the Arctic Grayling, with Emphasis on Heavily Fished Stocks

Cooperator: Rolland Holmes

Period Covered: July 1, 1983 to June 30, 1984

ABSTRACT

Population estimates of Arctic grayling, Thymallus arcticus (Pallas), greater than 150 mm fork length, were conducted on five sections of the lower 90 miles of the Chena River. Population levels in the lower river, sections 2b and 8a, were up from the low levels in 1982. Population levels in the other section were near average. Only 0.6% of the fish on the two lower river sections were mature, whereas an average of 13.6% of the fish in the three upper river sections were mature. Age III was the dominant age class, and the normally important Age IV year class was quite weak in 1983. The mean fork length for all sections was 195 mm. The average yearly mortality for Chena River grayling above Age III was 58.1%. A high proportion of the total mortality was due to fishing. The estimated rate of fishing mortality was 41.5%.

Three measures of stock recruitment were evaluated in 1983. Catch-per-unit-effort of Age I and II grayling, standardized seining of young-of-the-year grayling, and population estimates on grayling 100-149 mm all show promise as recruitment indices.

Creel census information collected from May 1 to September 15, 1983 along the upper Chena River revealed that an estimated 19,018 angler hours were expended to harvest 10,821 grayling. The estimated catch rate of 0.58 grayling caught and kept per hour was down from the 1982 level. Angler pressure and harvest figures by month are presented along with catch composition and a creel census summary since 1970.

The grayling intrastream migration study was continued in 1983. Recaptures totaled 114 grayling. Of these, 68% were recaptured in the same area as tagged. Of the 39 fish which showed movement, 19 had moved upstream and 20 had moved downstream.

Surveys were conducted on 21 small ponds in the area of the upper Chena River to determine their suitability as rearing habitat for young-of-the-year grayling. Seven of these ponds were chosen for rearing experiments to be conducted in 1984.

Two surveys of Fairbanks area streams were also conducted in 1983. Stream characteristics and data on the grayling population structure and shifts over time of the population structure of the Salcha River and the East Fork of the Chena River are presented.

KEY WORDS

Arctic grayling, Tanana drainage, electrofishing, population estimates, creel census, migrations, stock structure, population dynamics, tagging, stream surveys and enhancement.

BACKGROUND

The Chena River is typical of the clear, runoff type streams common to interior Alaska. The Chena originates in the Tanana Hills approximately 100 mi east of Fairbanks at lat. 65°N, long. 145°W and flows in a westerly direction, emptying into the Tanana River just below the city of Fairbanks. The entire watershed occupies approximately 1,900 sq mi, with the river basin 100 mi long and a maximum of 40 mi wide. The river has been divided into 17 sections for study (Fig. 1) (Table 1).

The flow of the Chena River at Fairbanks has an annual average of 1,418 cfs based on data collected by the U.S. Geological Survey since 1947. The maximum annual average was 3,160 cfs in 1949 and the minimum was 708 cfs in 1958. The 1967 flood accounted for the record maximum flow of 74,000 cfs through Fairbanks.

Like most interior Alaska clear runoff streams, the Chena River supports a large population of Arctic grayling, Thymallus arcticus (Pallas). While the Chena River contains many species of fish, the grayling is the principal species of recreational importance. Due to its proximity to Fairbanks, the Chena River supports the largest grayling fishery in the state.

The Chena Hot Springs Road, which parallels the Chena River from Mile 26 to its terminus at Mile 60, crosses the river seven times, providing easy access for fishermen and recreationists alike. It is in this area of intense fishing pressure that the 1983 creel census was conducted. Also within this area is the 250,000 acre Chena River Recreation Area.

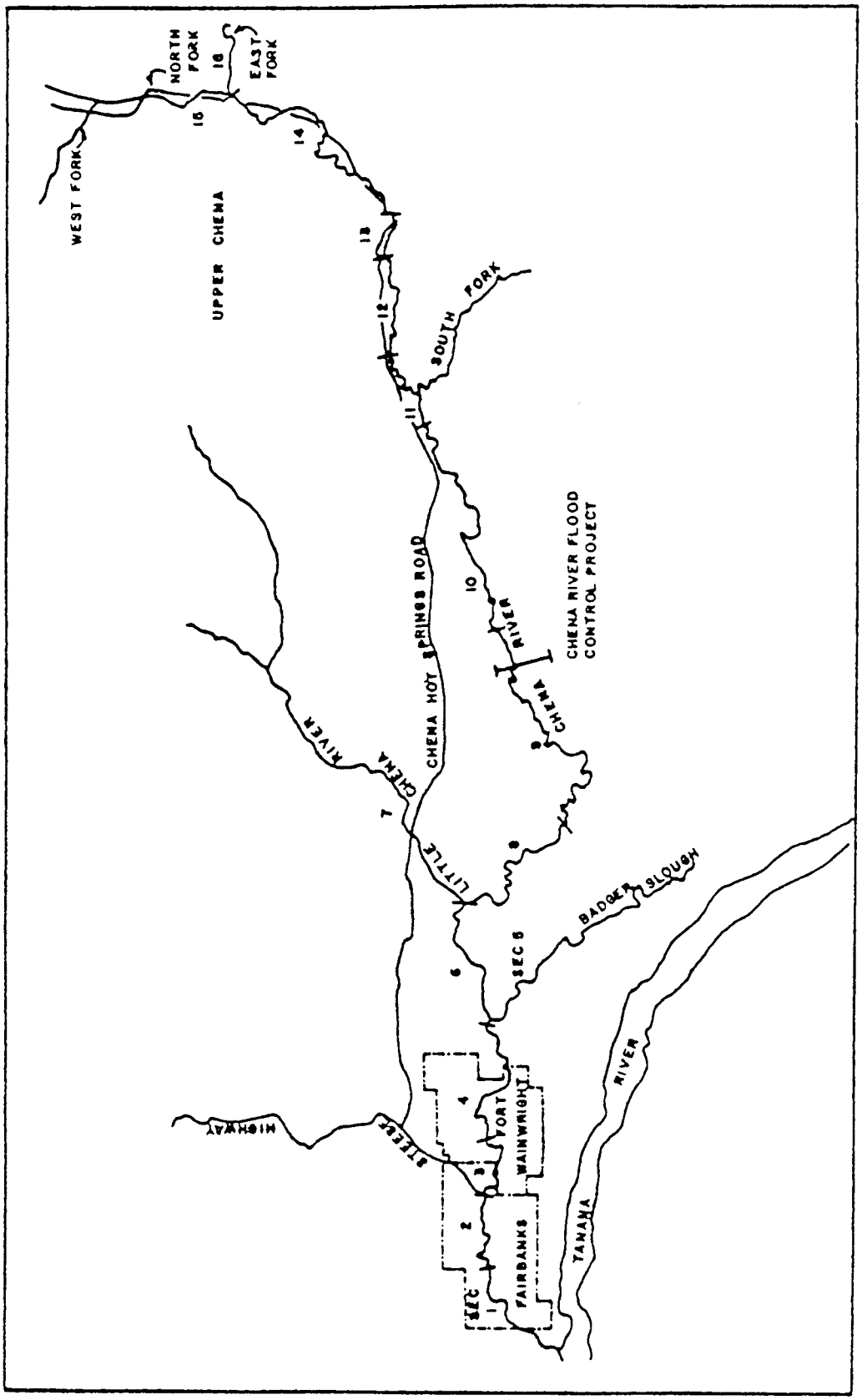

FIGURE 1. CHENA RIVER STUDY SECTIONS

Table 1. Chena River study sections.

Section Number	Section Name	River Miles	Section Length Miles
1	River Mouth to University Ave.	6.0	6.0
2a	University Ave. to Peger Road	6-8	2.0
2b	Peger Road to Wendell Street	8-11	3.0
3	Wendell St. to Wainwright Railroad	11-14.5	3.5
4	Wainwright Railroad Bridge to Badger Slough.	14.5-21.5	7.0
5	Badger Slough		16.5
6	Badger Slough to Little Chena	21.5-24.5	3.0
7	Little Chena River		61.5
8	Little Chena to Nordale Slough	24.5-31	6.5
9a	Nordale Slough to Bluffs	31-55.5	24.5
9b	Bluffs to Bailey Bridge	55.5-60	4.5
10	Bailey Bridge to Hodgins Slough	60-76	16.0
11	Hodgins Slough to Fourmile Creek	76-84	8.0
12	Fourmile Creek to First Bridge	84-88.5	4.5
13	First Bridge to Second Bridge	88.5-91	2.5
14	Second Bridge to North Fork	91-95.5	4.5
15	North Fork of Chena River		35.0
16	East Fork of Chena River		62.0
17	West Fork of Chena River		35.0

Recent campsite construction here by the Alaska Department of Natural Resources, Division of Parks, has increased access to the river and furthered recreational use.

The Department of Fish and Game has monitored angler use and harvest levels on the upper Chena since 1967 (Van Hulle, 1968; Roguski and Winslow, 1969; Roguski and Tack, 1970; Tack 1971, 1973, 1975, 1976; Hallberg 1977-1982, Holmes, 1983). Use levels have shown a general increase, while catch rates and fish size have remained relatively constant.

Intensive studies of Arctic grayling stocks have been conducted in selected index areas for several years. Standard mark and recapture methods to estimate grayling numbers were initiated by Roguski and Winslow (1969), and continued by Roguski and Tack (1970), Tack (1971-1976) Hallberg (1977-1982) and Holmes (1983). Information obtained during the population estimates also includes length frequencies, age and length composition, and annual survival/mortality rates, all of which aid in understanding grayling life history and evaluating the health of the exploited stocks of the Chena River.

The U.S. Army Corps of Engineers has constructed a flood control project on the Chena River at river Mile 47. The project is designed to channel flood waters from the upper Chena River directly into the Tanana River, bypassing the city of Fairbanks and the lower Chena, thus protecting both from flood waters. Other factors affecting the river include the hot springs and resort on the North Fork, numerous recreation cabins on the North and West Forks, and a military campground near Mullen Slough. Hydraulic gold mining operations are active on the Little Chena River and East Fork, and mining activities are scheduled on the South and West Forks. These activities, along with the problems associated with a city and military complex located in the lower 15 mi of the river, pose a variety of management problems to the Sport Fish Division in our ongoing efforts to maintain the integrity of the Chena River and its fauna.

RECOMMENDATIONS

Research

1. Population estimates on the five index sections of the Chena River should be continued.

2. Index area sampling should be performed on the Salcha and Chatanika Rivers as time permits.

3. Evaluation of recruitment estimating techniques should be continued on the Chena River.

4. Investigations of grayling populations should continue on headwaters of major river systems in interior Alaska.

5. Knowledge of mortality factors of Chena River grayling should be refined with special emphasis placed on fishing and hooking mortality.

6. Creel census programs should be continued on the Chena River system with emphasis on obtaining statistically based catch data. Catch data on other area grayling fisheries should be obtained as time permits.

7. Grayling population structure in the upper Chena River in the area of heavy fishing pressure should be investigated and compared with unexploited stream sections.

8. Use of small radio transmitters to investigate mixing of upper and lower Chena River grayling stocks during spawning, rearing, and overwintering should be evaluated.

9. Develop a model of predicted grayling yield based on mortality, recruitment, movement, and use data obtained from the Chena River.

10. Evaluate growth rates of fry stocked into upper Chena River rearing ponds.

Management

1. Monitoring of development projects affecting the Chena River should be continued.

2. Evaluate the need for grayling stock enhancement on the Chena River.

3. Assess grayling egg sources, and evaluate fry rearing areas on the upper Chena River.

OBJECTIVES

1. To estimate the number of grayling as well as to assess and compare age and size composition of the grayling stocks in five Chena River and one Chatanika River index sections during July and early August.

2. To determine catch per unit of effort and age and size composition of grayling harvested in major Fairbanks area fisheries including the Chena and Chatanika Rivers and Badger and Piledriver Sloughs. To perform a statistically based creel census to estimate angler hours and harvest on the upper Chena River from May 1 to September 15.

3. To estimate total annual mortality of grayling stocks within the five Chena River and one Chatanika River index sections. To attempt to estimate fishing mortality in the upper Chena River index section.

4. To develop methods to index or estimate stock recruitment in the five Chena River and one Chatanika River index sections.

5. To evaluate the importance of yearly movements and migrations of grayling within the Chena River in contributing to angler harvests and stock maintenance and quality through a tagging program to assess movements and harvests.

6. To perform summer and winter surveys of shallow ponds in the area of the upper Chena River to determine their suitability as rearing areas for grayling fry for future stock enhancement.

7. To determine the need for enhancement by stocking of grayling in the Chena River through the analysis of mortality, movement, and recruitment data.

TECHNIQUES USED

Intensive studies of Arctic grayling in 1983 were conducted on five index sections in the lower Chena River, sections 2b, 8a, Dam Site, 10b, and 12. Section 2b and 8a both lie below the newly constructed Chena River Lakes Flood Control Project and may be directly impacted during times of flooding. Section 2b lies adjacent to Fairbanks, is easily accessible and has, over the years, been exposed to heavy development. Section 8a is located approximately 15 mi upstream of Fairbanks and, while this area remains fairly accessible, it has not yet experienced intensive development. The upper three sections are located above the flood control structure. The area known as the Dam Site is the 3 mi stretch of river directly upstream of the control structure. It is in this area that flood waters from the Chena River would enter the floodway and eventually find their way into the Tanana River. Estimates here began in 1972 (Tack 1973) and will be continued in order to monitor any changes in the grayling population structure as it relates to the flood control project. Section 10b is undeveloped, relatively inaccessible, and angler utilization is minimal; thus it serves as a control area in our population estimates. A new index area, section 12, was initiated in 1983. This section is located in the upper Chena River in the heavily fished portion of the river. Population size and age and growth information from this section will be compared with catch sample data obtained from the upper Chena River creel census. Grayling sampling on the Chatanika River was not performed in 1983 due to mining siltation.

Grayling for tagging, population estimates, and age and length composition were captured by a boat-mounted, electrofishing unit described by Van Hulle (1968) and Roguski and Winslow (1969). Electrofishing passes were made through each of the 3-mile-long Chena River index sections on three successive days. Mark-recapture population estimates and their associated 95% confidence intervals were calculated using the Schnabel technique, as described in Ricker (1978).

Scale samples for age determination were taken from a subsample of 25% of the fish captured during the electrofishing runs. Scales were

cleaned and impressed on 20 mil acetate, using a Carver press at 20,000 psi, heated to 200°F for 30 seconds. Scales were aged using a Bruning 200 microfiche reader.

Age frequencies obtained from the index sampling in sections 2b, 8a, Dam Site and 10b through 1983 were multiplied by population estimates to obtain per-mile estimates of numbers of grayling in each age group. These data were used to estimate annual survival and mortality by two different methods, catch curve analysis and cohort analysis.

Three methods of indexing stock recruitment were evaluated this year. The first method involved Schnabel mark-recapture population estimates of 100-149 mm grayling in each index section. These population estimates were made concurrently with the estimates of grayling greater than 150 mm. By the second method, Age I and II grayling were segregated using length frequency analysis. The catch per unit effort of each of the age classes in each index section was then considered as an index of abundance. For the third method, a series of seine hauls were made in the upper, middle, and lower Chena. The catch-per-unit-effort of young-of-the-year grayling from these seine hauls was used as an index of the relative abundance of age 0 grayling.

A roving creel census was conducted along the upper Chena River. Total angler hours were estimated using counts of fishermen at 2 p.m. on six randomly-selected days per month within weekend and weekday strata (Holmes 1981). Interviews were made with anglers contacted during the roving creel census to compute catch statistics and angler profile information. All angler-caught fish were measured and scale samples taken.

Small ponds and gravel pits in the area of the upper Chena River were surveyed for physical, chemical, and biological characteristics to determine their suitability as grayling fry rearing areas. Winter sampling was performed to estimate levels of dissolved oxygen in the ponds.

Grayling movement studies emphasized tagging and recapture efforts in areas which have not been heavily sampled in the past few years. Grayling were captured by hook and line and boat-mounted electrofishing.

Grayling greater than 200 mm in length were tagged using a numbered Floy internal anchor tag inserted into the dorsal musculature. No grayling were tagged during the five index section population estimates.

FINDINGS

Population Estimates

Chena River:

The 1983 population estimates show increases of 161 and 51 grayling per mile for the lower river sections 2b, and 8a, respectively (Table 2).

Table 3. Population estimates for Arctic grayling greater than 150 mm fork length in index sections of Chena River 1968-1983.

River Section	Year	Date	(Schnabel Estimate) gr/mi
2b	1968		767
	1969		1,323
	1970	July 2-10	1,479
	1971	Aug. 30-Sept. 3	2,095
	1972	June 22-26	978
	1973	July 3-10	679
	1974	July 25-28	642
	1976	July 22-24	596
	1977	July 11-14	479
	1978	July 25-28	254
	1979	July 26-30	316
	1980	July 1-4	463
	1981	Aug. 7-10	419
	1982	July 16-20	185
	1983	July 13-15	346
8a	1979	Aug. 20-23	269
	1980	July 14-17	284
	1981	Aug. 3-6	359
	1982	July 13-15	139
	1983	July 5-7	190
Dam Site	1972	June 27-29	1,306
	1973	July 18-19	800
	1974	July 9-11	416
	1976	Aug. 4-6	464
	1977	July 26-30	437
	1978	Aug. 8-11	495
	1979	July 17-20	261
	1980	July 29-Aug. 1	339
	1981	Aug. 11-14	483
	1982	July 23-27	371
	1983	July 8-12	334
10b	*1970	June 7-July 7	1,873
	1980	Aug. 12-15	1,163
	1981	July 21-24	1,391
	1982	July 28-30	1,400
	1983	July 19-21	1,458

* The 1970 estimate was conducted on the entire 16 mi of section 10.

The large discrepancy in catchability estimates in the Dam Site section between 1982 and 1983 is probably a result of the high water conditions encountered during 1982. The higher muddy water would result in lowered catch efficiency. This points up the effect that year to year variability in water conditions can have on catch rates. In the future, water depth, velocity, and turbidity will be measured during sampling so that the effects of water conditions can be accounted for.

Age and Length Structure

Chena River:

Age determinations were made from scale samples taken from 477 grayling captured during the index sampling (Table 4). The Age III year class was very strong (45.1% of the total population). This is well above the past 5 year average of 32%. On the other hand, the normally strong Age IV year class was very weak (8.0% of the total population). This is well below the five year average of 22%. This combination of a strong Age III year class and a weak Age IV year class was predicted based on 1982 age frequencies (Holmes 1983).

Poor spawning success or young-of-the-year survival appear to be the major determinates of year class strength. As was the case last year, a high correlation was found between numbers of grayling and the average rate of river discharge (ft^3/sec) during May, June, and July of their natal years ($r=-0.95$ and -0.89 for Age III and IV fish, respectively) (Figures 2 and 3). This correlation of year class strength and water discharge was noted by Tack (1971) when an entire Chena River grayling year class was missing due to the major flood of 1967.

All 1,949 grayling captured during the index area sampling were measured for length frequency analysis (Table 5). As in the past, a higher percentage of larger and older fish occurred in the upper river sections than in Sections 2b and 8a. This is apparent both by length frequency analysis and by comparisons of mean lengths. The mean lengths in each index section in 1983 were very similar to those of the past 5 years (Table 6). Only section 2b has shown a steady decline in mean length since 1976 ($r=-0.90$, $P<0.05$). This decline in length parallels the population decline in section 2b.

The increase in average fork length between sections as one moves upstream is paralleled by an increase in percent of mature fish (>270 mm) (Table 5). Section 2b and 8a averaged only 0.6% mature fish. In 1976 nearly 5% of the fish in section 2b were mature. The Dam Site, 10b, and section 12 had 19.1, 11.0, and 10.8 percent mature fish respectively. Tagging and mortality studies are being done to attempt to determine if higher mortality in the lower river sections or upstream migration are responsible for the lack of mature fish in the lower river.

Table 4. Age and length composition of 477 randomly sampled grayling in section 2b, 8a, Dam Site, 10b, and 12, 1983.

Fork Length mm	Age									
	0	I	II	III	IV	V	VI	VII	VIII	IX
50-59	1									
60-69	5									
90-99		5								
100-109		7								
110-119		10								
120-129		9	1							
130-139		2	8							
140-149			9							
150-159			25	25						
160-169			9	41						
170-179			1	55						
180-189				48						
190-199				34	5					
200-209				9	7	2				
210-219				3	11	5				
220-229					11	19				
230-239					2	20	1			
240-249					1	13	2			
250-259					0	13	2			
260-269					1	4	6			
270-279						7	7	2		
280-289							7	1		
290-299							2	2		
300-309							1	3		
310-319							1	1	1	
320-329								0	2	
330-339								2	2	
340-349								2	0	
350-359									1	
360-369									0	
370-379									1	
380-389										
390-399										1
Number	6	33	53	215	38	83	29	13	7	1
Age frequency %	1.3	6.9	11.1	45.1	8.0	17.4	6.1	2.5	1.5	0.2
$\bar{x}$ fork length (mm)	62	114	151	177	216	239	273	307	338	390

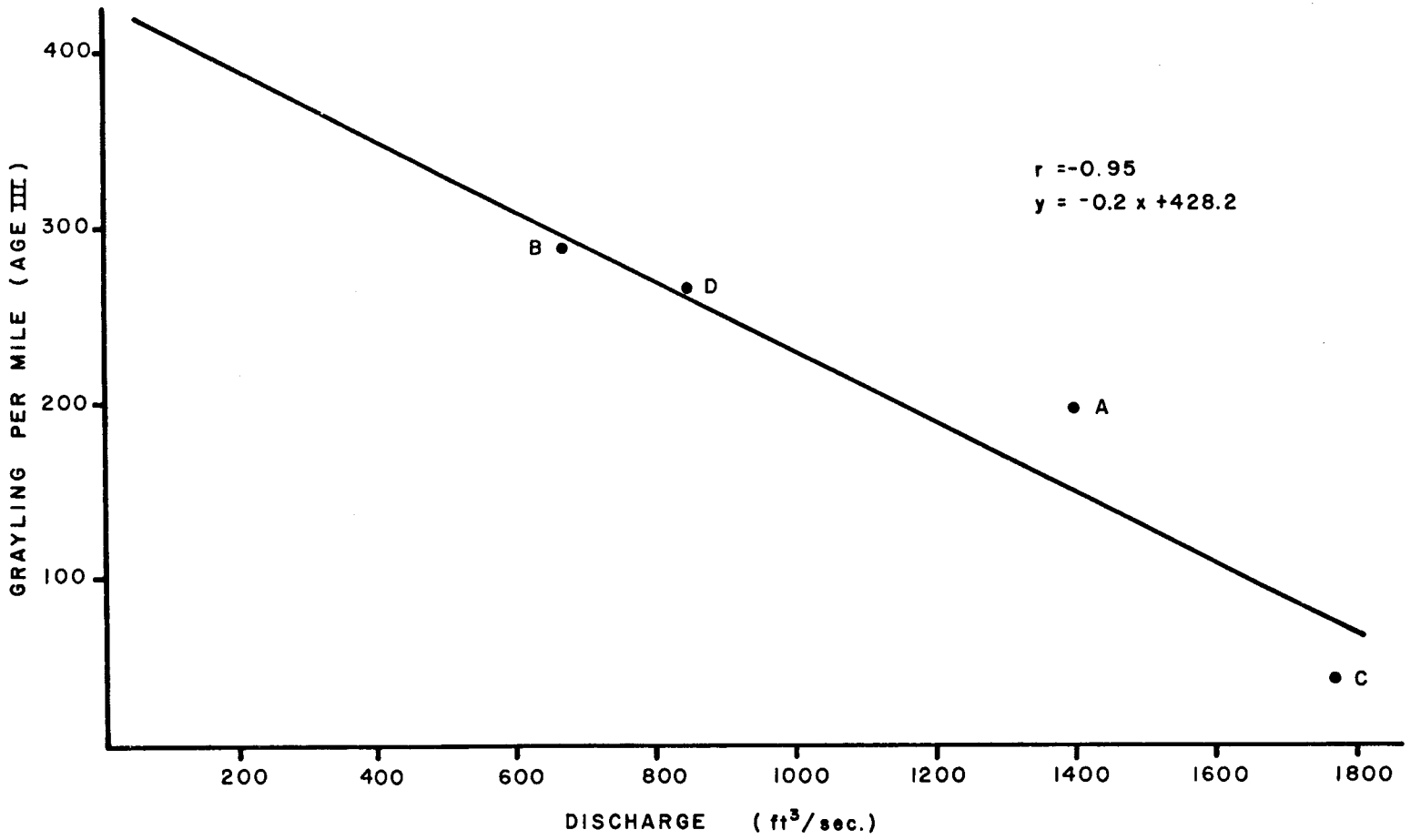

Figure 2

The relation of the average number of Age III grayling per mile in four Chena River sections combined (2b, 8a, Dam Site, and 10b) to the rate of water discharge during May, June, and July of the natal year for each age class. Natal year: A=1977, B=1978, C=1979, D=1980.

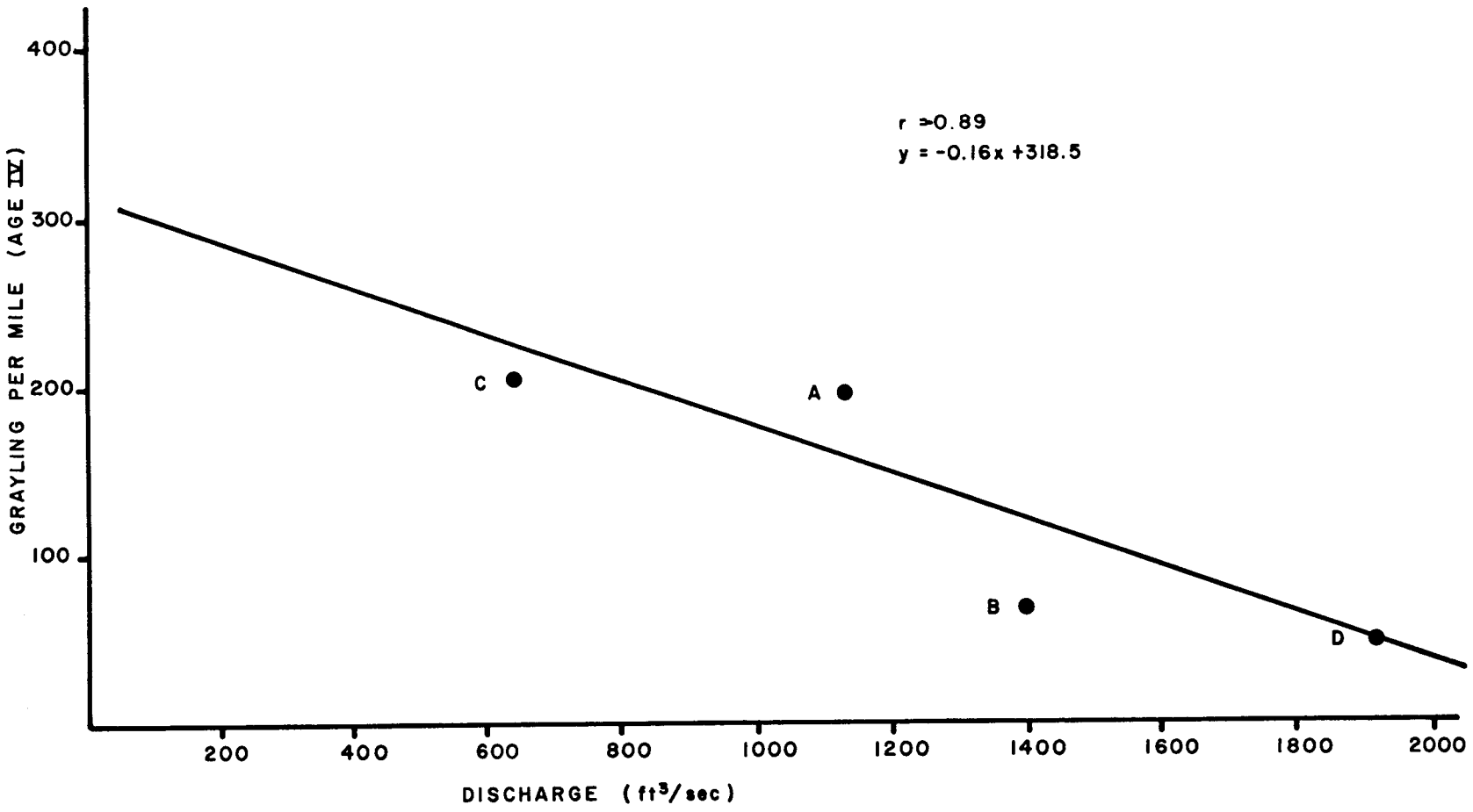

Figure 3

The relation of the average number of Age IV grayling per mile in four Chena River sections combined (2b, 8a, Dam Site, and 10b) to the rate of water discharge during May, June, and July of the natal year for each age class. Natal year: A=1976, B=1977, C=1978, D=1979.

Table 5. Length frequency (in percent of sample) of 1,949 grayling sampled from five sections of the Chena River, 1983.

Fork Length mm	2b	8a	Dam Site	10b	12
50-59	1.2				
60-69	2.5				
70-79					
80-89		0.4			0.8
90-99		1.3	0.3		1.7
100-109	1.0	2.7	0.9	0.5	0.4
110-119	4.2	3.1	0.3	0.2	0.4
120-129	4.0	4.0	0.6	0.3	0.8
130-139	1.9	1.3	2.1	0.9	2.5
140-149	5.0	1.3	5.3	3.4	4.2
150-159	8.3	14.2	9.9	6.7	13.4
160-169	7.3	16.1	13.0	12.8	13.4
170-179	11.5	12.1	8.4	13.6	13.4
180-189	19.4	5.8	5.0	11.1	7.1
190-199	13.5	4.0	2.8	4.8	3.3
200-209	6.9	5.8	1.9	3.7	1.3
210-219	5.6	8.1	4.3	3.0	0.8
220-229	3.1	6.7	4.6	7.8	2.1
230-239	1.5	4.5	6.8	7.4	6.3
240-249	1.5	4.0	5.3	5.8	7.1
250-259	1.0	1.8	4.3	3.7	5.9
260-269	0.2	1.3	5.0	3.4	4.2
270-279	0.2	...	6.5	3.1	3.3
280-289	0.2	...	3.4	2.7	1.3
290-299	...	0.4	4.6	0.8	0.8
300-309	...	...	1.9	1.6	0.8
310-319	...	0.4	0.9	1.2	1.3
320-329	...	...	0.6	0.5	1.3
330-339	...	...	0.6	0.3	0.8
340-349	...	...	0.3	0.5	0.4
350-359	...	...	...	0.3	0.8
360-369	...	...	...	...	...
370-379	...	...	0.3	...	...
380-389	...	...	...	...	...
390-399	...	...	...	...	...
400 +	...	...	...	...	...
Number	521	221	323	643	241
Mean Length (mm)	173.3	180.5	215.7	205.9	198.4
Length Range (mm)	51-284	85-316	96-375	102-355	85-358

Table 6. Average fork lengths (mm) of grayling sampled from index area population estimates, 1976-1983.

Year	Chena River Section				
	2b	8a	Dam Site	10b	12
1976	201		220		
1977	190		204		
1978	181		183		
1979	178	193	192		
1980	178	186	204	206	
1981	177	196	187	178	
1982	171	174	188	202	
1983	173	181	216	206	198

Survival and Mortality

Total Mortality:

By following the declines in the numbers of individuals in an age class from 1980 to 1983 (cohort analysis), estimates of survival and mortality were obtained. Estimates of total annual mortality of between 53.6% and 61.8% were calculated for the 1974 to 1977 year classes (Table 7). The mean mortality estimate for all year classes was 58.1%. This value is very similar to the 1982 average mortality estimate of 61.3%. The average yearly survival was estimated as 41.9% of the population over Age III. These mortality and survival estimates represent the population declines of four age classes for 4 years each. The consistent nature of these estimates indicate that they are relatively reliable.

Fishing Mortality:

Knowledge of the level of fishing mortality is very important to the management of a fishery, especially a relatively intense fishery such as is found on the Chena River. Using population estimates and catch statistics, I developed a general estimate of the proportion of total mortality on the Chena River due to fishing.

In 1983 there were an estimated 57,456 grayling larger than 150 mm in the lower 108 miles of the Chena River. With an annual mortality rate of 58.1%, an estimated total of 33,382 grayling died in the Chena in 1983. From the creel census, an estimated harvest for the entire river of 23,834 grayling was obtained (10,821 upper Chena, 13,013 lower river). Thus, over two thirds of all the Chena River mortality was a result of fishing. The estimated rate of fishing mortality, then, was 41.5%, and the estimated rate of natural mortality was 16.6%.

It is clear that sport fishing is the major mortality factor in the Chena River. However, the total mortality level may not be abnormally high since mortality rates of around 60% for grayling are not uncommon. Even in the comparatively lightly exploited Goodpaster River, Tack (1975) estimated the mortality rate at 57%.

The estimate of fishing mortality does not take into consideration mortality caused by hooked-and-lost or hooked-and-released fish. If a high percentage of these fish die, it would increase the actual fishing mortality. One indication that hooking mortality may not be high is the number of fish with hook scars examined during the index area sampling. Almost 36% of all the fish greater than 200 mm had a major hooking wound (torn jaw, missing maxillary, damaged eyes, etc.). This indicates that over one-third of the fish in the stock have been hooked and released, or lost and have survived. Thus, it may be that grayling are resistant to hooking stress (Tack 1972). A hooking mortality study will be conducted in the future to verify this.

Table 7. Estimated average number of grayling per mile for each age group for combined Chena River index areas 2b, 8a, Dam Site, and 10b, 1980-1983. Average mortality and survival rates are estimated by two methods.

Age	Year Sampled				Natal Year	Year Class	
	1980	1981	1982	1983		Mortality %	Survial %
III	194	284	38	262			
IV	194	65	204	47	1980		
V	81	92	42	101	1979		
VI	47	45	25	36	1978		
VII	9	12	16	15	1977	57.6	42.4
VIII	1	6	16	9	1976	59.5	40.5
IX	0	0	0	1	1975	53.6	46.4
					1974	61.8	38.2
Catch Curve							
Mortality %	36.9	56.3	11.1	55.6			
Survival %	63.1	43.7	88.9	44.4			

Recruitment

The Chena River grayling fishery is heavily dependent upon the III and IV year age classes (Hallberg 1982, Holmes 1983). Since low year classes can have a major effect on population structure and the fishery, a method of estimating upcoming year class strength is desirable.

In 1983, three methods of indexing or estimating the strength of Age 0, I, and II year classes (to be used as indices of recruitment) were evaluated. The first method involved actual mark-recapture population estimates of grayling 100-149 mm in length. These estimates were performed concurrently with the estimates of grayling larger than 150 mm in each Chena River index section. The 100-149 mm length range encompasses part of the Age I and part of the Age II year classes and represents a size range which should recruit to the fishery the next year.

Population estimates of the 100-149 mm long fish were quite low (Table 8). This could be a result of actual low population numbers or of difficulty with capturing these smaller fish. The number of recaptures in each section was also very low. This resulted in very large confidence intervals around the estimates. The value of this method will be determined when we relate these population estimates to numbers of older fish in future years.

The second index of recruitment involved determining the catch-per-unit-effort of Age I and II grayling from the index sampling of sections 2b, 8a, Dam Site, and 10b. All grayling captured during the index sampling were measured. Using length frequency analysis, the average catch rate of Age I and II grayling captured in all sections was determined for 1980 through 1983 (Table 9). A high correlation ($r=0.946$) was found between the catch rate of Age I fish and the catch rate of Age II fish in the following year (Figure 4). A similarly high correlation ($r=0.956$) was obtained between the catch rate of Age II grayling and the average number of Age III grayling per mi in the index sections the following year (Figure 5). These high correlations indicate that this method may be very useful as an index of the strength of future year classes. However, more work needs to be done since, due to the low number of years of data available, the correlations mentioned were not statistically significant ($P > 0.05$).

The third recruitment index evaluated the strength of the young-of-the-year age class. A series of 15 seine hauls were made in various habitat types in areas of the upper, middle, and lower Chena River. The average catch rate of Age 0 fish decreased in an upstream direction: 60.4, 27.7, and 3.5 Age 0 grayling per 100 ft of seine haul for the lower, middle and upper Chena River, respectively. The relative strength of this Age 0 year class and the value of this estimating technique will be evaluated in future years as more data become available.

Of the three recruitment estimating methods, the population estimates of 100-149 mm grayling appeared to be the least promising. Very low capture and recapture rates resulted in low population estimates with

Table 8. Population estimates, catch, rates, and catchability estimates for grayling 100-149 mm in five sections of the Chena River, 1983.

Section (River Mile)	Date of Estimate	No. of Recapture	Catch Date gr/day	Catchability % caught/day	Schnabel Estimate gr/mi	95% Confidence Intervals for Schnabel Est. gr/mi
2b (8-11)	July 13-15	3	29	3.6	267	91-1,336
8a (26-29)	July 5-7	2	9	7.1	42	12-418
Dam Site (46-49)	July 8, 11, 12	1	10	3.4	98	17-977
10b (66-69)	July 26-28	1	12	3.1	129	23-1293
12 (85-88)	July 19-21	3	8	14.0	18	6-92

Table 9. Average catch rate for Age I and Age II grayling and the estimated number of Age III grayling per mi for Chena River index sections 2b, 8a, Dam Site, and 10b combined.

Age	Year Sampled				Natal Year
	1980	1981	1982	1983	
I	20.4	82.4	22.2	24.1	
II	117.0	26.4	143.3	67.8	1982
III	194	284	38	262	1981
					1980
					1979
					1978

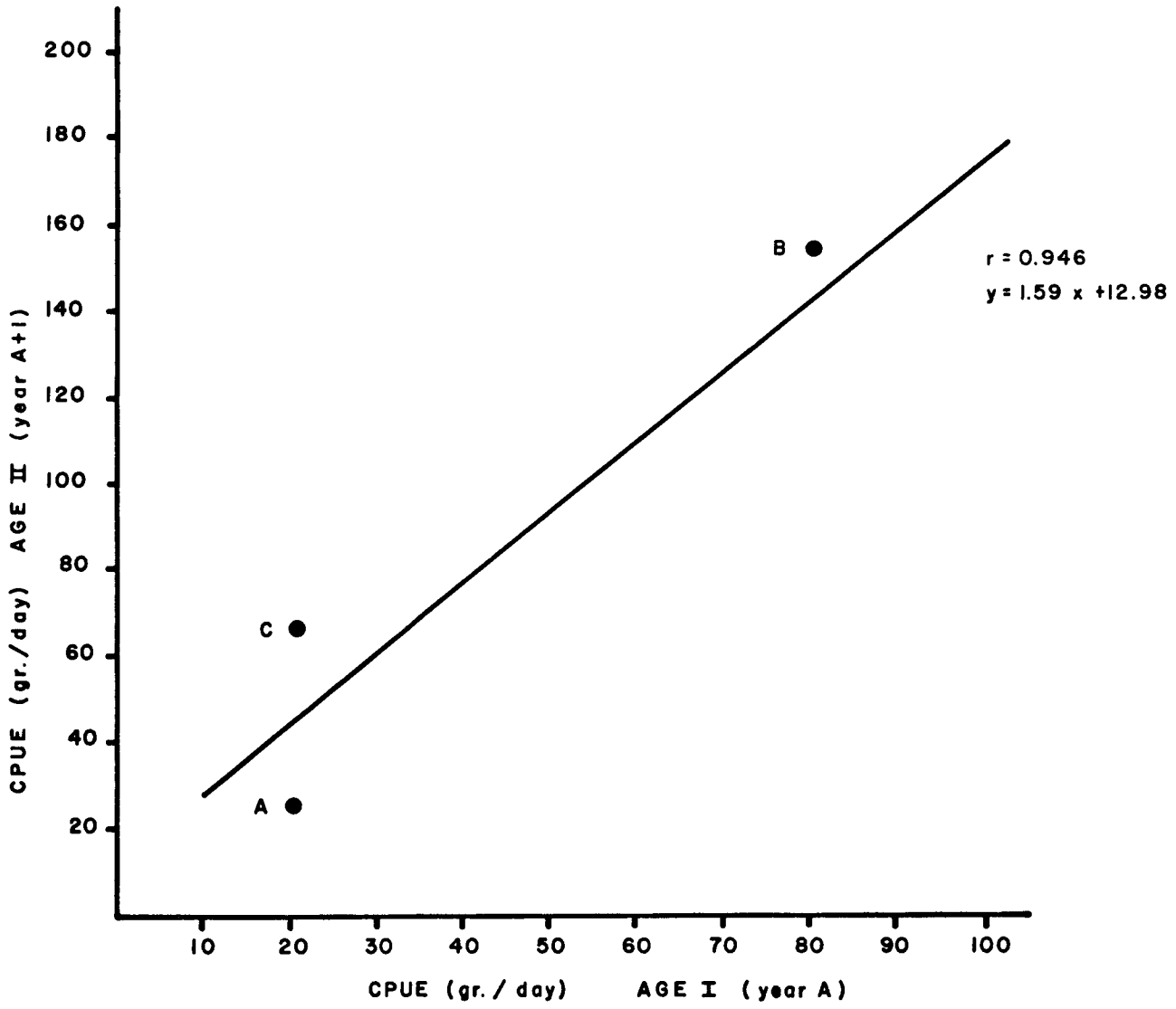

Figure 4

Relation of the CPUE of Age I grayling from four Chena River sections combined (2b, 8a, Dam Site, 10b) to the CPUE of Age II grayling in the subsequent year. Year class: A=1979, B=1980, C=1981.

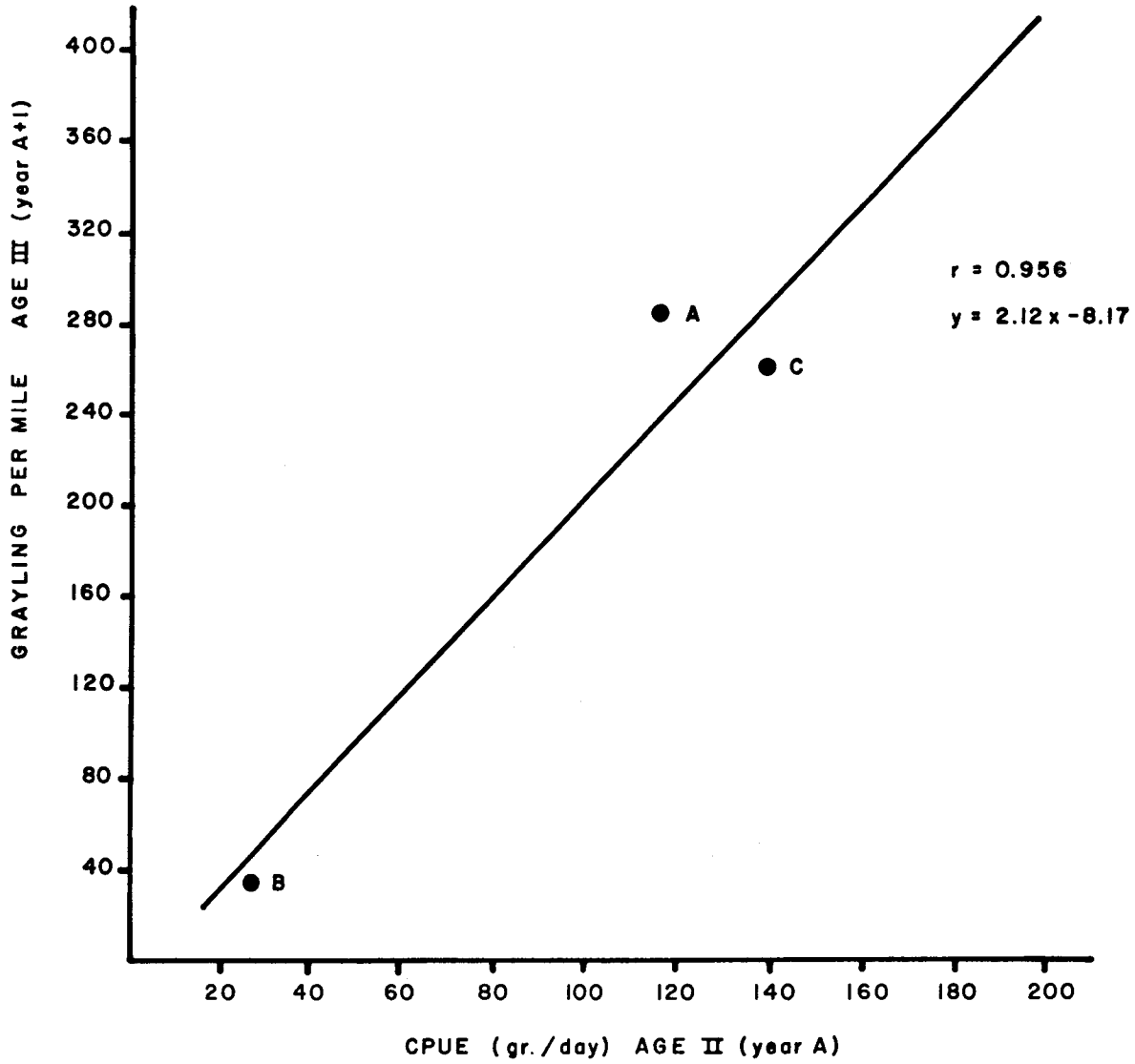

Figure 5
Relation of the CPUE of Age II grayling from four Chena River sections combined (2b, 8a, Dam Site, 10b) to the estimated population of Age III grayling in the subsequent year. Year class: A=1978, B=1979, C=1980.

wide confidence intervals. However, there was a very high correlation ($r=0.985$; $p<0.05$) between these population estimates and the catch-per-unit-effort of Age II grayling in each section (Figure 6). This indicates that the population estimates of grayling 100-149 mm may be relatively accurate (despite low recapture rates) and may indicate low recruitment for next year.

The catch-per-unit-effort estimates of Age I and especially Age II grayling taken from the population estimates appeared more accurate. Based on the regression of Age II to Ages III grayling (Fig. 5), there will be an average of 136 Age III grayling per mile in 1984. This is well below the previous 4 year average of 195 Age III grayling per mile. Also, the regression of Age I to Age II grayling (Fig. 4) predicts an electrofishing CPUE of 51 Age II grayling per day in 1984 which is well below the 4 year average of 89 Age II grayling per day. Knowledge of similar low year classes in the future may allow us to enhance the year class strength through a stocking program.

Creel Census

Upper Chena River:

Results of the 138 day creel census (May 1 - Sept. 15) appear in Table 10. During this period, a calculated 19,018 angler hours were expended to harvest 10,821 grayling from the upper Chena River above Mile 26 of the Chena Hot Springs Road. The estimated catch rate was 0.58 grayling caught and kept per hour. With catch-and-released fish included, the catch-per-unit-effort was 1.02 grayling per hour.

Relatively good weather conditions resulted in consistently high use levels for May, June, and July. However, poor weather and higher water levels probably accounted for the much lower use levels in August and September. Overall, the 1983 total angler use was very near the summer of 1982 level.

The catch-per-unit-effort was relatively high in May and gradually decreased throughout the summer until it increased again in September. This trend is commonly seen in the Chena, with the higher catch rates in the early and late season reflecting grayling migrations through the fishery. The other major factor affecting the catch rate is water conditions. High waters due to rain often reduce catch rates, and in 1983, silty water due to placer mining on the East Fork of the Chena River reduced the catch-per-unit-effort to near zero during parts of July and August.

A summary of creel census results since 1970 appears in Table 11. Since 1980 the months of May and September have been included in the creel census. The 1983 total of 19,018 angler hours is very near the average use since 1980 of 19,055 angler hours. However, the CPUE and, therefore, the harvest are somewhat lower than in recent years.

It appears that weather conditions have a major effect on use levels on the Chena River. Since 1983 each time a creel census count was made,

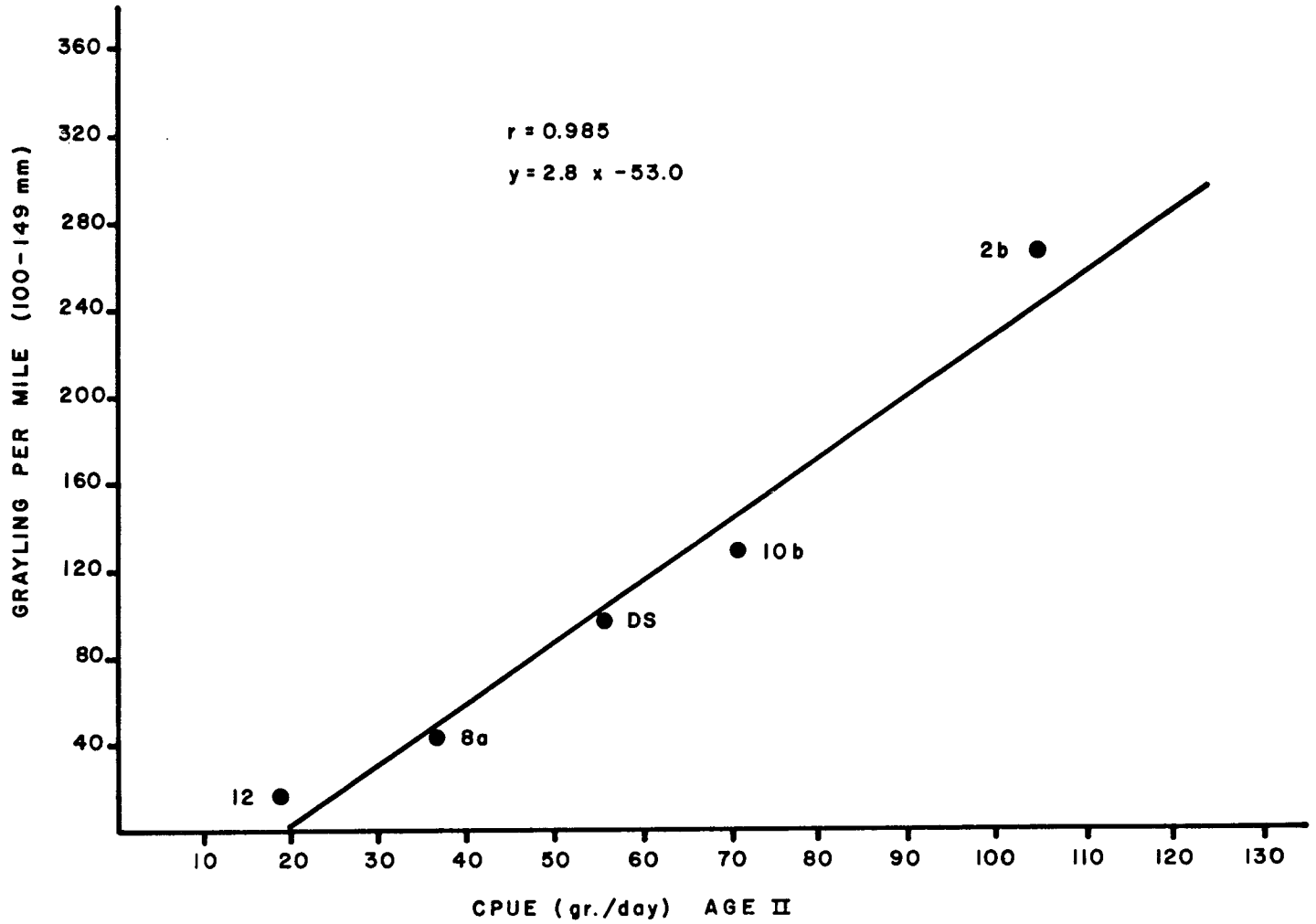

Figure 6
Relation of the CPUE of Age II grayling to the estimated population of grayling (100-149 mm) in each Chena River study section.

Table 10. Creel census results of the Arctic grayling fishery on the upper Chena River adjacent to the Chena Hot Springs Road, May 1-Sept. 15, 1983.

Period	Angler Hours			Grayling Kept per Angler Hour	Total Gr Caught per Angler Hour	Harvest	Mean Fork Length (mm)
	Weekday	Weekend	Total				
May	1,672	4,187	5,859	0.71	0.84	4,160	278.5
June	1,767	2,552	4,319	0.44	1.34	1,900	255.8
July	2,530	3,135	5,665	0.49	0.78	2,776	230.2
August	1,645	554	2,199	0.37	0.55	814	215.4
Sept. 1-15	448	528	976	1.2	1.6	1,171	270.6
Total	8,062	10,956	19,018	0.58	1.02	10,821	259.6

Angler Comp. (%)	
Local Residents	69.9
Military	13.5
Tourists	16.6

Table 11. Summary of creel census results for the upper Chena River, 1970-1983*.

Year	Date	Days	Total Angler Hours	Total Grayling Harvest	Grayling Caught & Kept Per Angler Hour
1970	May 1-31 July 14-Aug. 29	78	12,518	6,770	0.54
1972	May 25-Aug. 27	95	13,116	10,099	0.77
1974	July 01-Aug. 31	62	11,680	18.049	1.55
1975	June 01-Aug. 31	92	22,657	14,067	0.62
1976	June 01-Aug. 31	92	10,762	4,161	0.39
1977	June 01-Aug. 31	92	13,536	9,406	0.69
1978	May 29-Aug. 31	95	10,508	6,898	0.65
1979	June 01-Aug. 31	92	12,744	10,459	0.82
1980	May 08-Sept. 30	144	20,827	16,390	0.78
1981	May 01-Aug. 31	123	15,896	13,549	0.80
1982	May 01-Sept. 15	138	20,379	12,603	0.62
1983	May 01-Sept. 15	138	19,018	10,821	0.58

* Data before 1982 taken from Hallberg, 1982.

the weather was rated from 1 to 4 where 1 = very good weather and 4 = very poor weather. Over this period, the average number of fishermen counted on a day with a rating of 1 was 26, while an average of only 5 people were counted on days with a rating of 4. The average number of fishermen per count was 19 on days rated 2 and 13 on days rated 3, respectively. It's clear, then, that weather conditions are a major determinant of use; and therefore, year-to-year fluctuations in use should be evaluated in this light.

For comparison with past years, creel census results from June 1 - Aug. 31 were calculated (Fig. 7). The angler hour total for this period was 12,183, which is slightly down from the 8 year average of 13,678. The June - August harvest of 5,490 grayling and the CPUE of 0.43 grayling per hour were both lower than their previous 8 year averages of 9,065 and 0.66 for harvest and CPUE, respectively.

A partial explanation of the low catch rate and harvest for 1983 may be the very low representation of both Age III and IV grayling in the creel (Table 12). Age IV is probably low due to the weakness of that age class in the population (Table 4). However, the Age III year class is very strong (45.1% of the total populations) (Table 4), but it was not well represented in the creel. The average length of the Age III fish in 1983 was 177 mm. The previous 3-year average for this age class was 192 mm. The smaller size of the 1983 Age III fish may be responsible for their lack of representation in the creel. The total CPUE (including those fish which were caught and released) was 1.02 grayling per hour. This higher CPUE may indicate that a large percent of the anglers found the 1983 Age III grayling too small to keep.

The average size of grayling harvested in the fishery was 259 mm. The relatively minor influences of both the Age III and IV year classes in the catch probably account for the large average size. Fish caught in May averaged 278.5 mm. Over half of the 4,160 fish harvested in May were of spawning size (>270 mm). This harvest represents over half of the estimated population of spawning adults in the upper Chena. Therefore, fishing can have a significant impact on the adult population. It should be noted however, that many of the larger fish which are harvested in May and September probably represent adults which are migrating through the fishery on their way to or from one of the forks of the Chena and, therefore, the percentage of adults harvested from the upper Chena is not as great as it appears. Still, the harvest of larger fish (especially in the spring) should be monitored for any shifts which might indicate a shortage of spawning adults.

Tagging Study

This study was initiated in June of 1980 to further our understanding of intrastream movements of grayling in the Chena River. Past information, including age and length frequencies and creel census data, had indicated a general upstream movement of grayling as they grew older. We hoped to learn, through the tagging study, if this upstream movement occurred and if it was important in sustaining catch rates on the upper Chena River.

Table 12. Age and length composition of 101 grayling sampled during the upper Chena River creel census May 1-Sept. 15, 1983.

Fork Length mm	Age									
	0	I	II	III	IV	V	VI	VII	VIII	IX
170-179				1						
180-189				1						
190-199				4	1					
200-209					1					
210-219					1	1				
220-229					2	2				
230-239					0	8				
240-249					2	7	1			
250-259						15	3			
260-269						6	5			
270-279						3	5	1		
280-289						1	4	3		
290-299							1	3		
300-309								1	2	
310-319								2	5	
320-329								1	1	
330-339								2	0	
340-349									2	2
350-359										0
360-369										1
Number				6	7	43	19	13	10	3
Age frequency %				5.9	6.9	42.6	18.8	12.9	9.9	3.0
$\bar{x}$ fork length (mm)				188	221	250	270	303	318	349

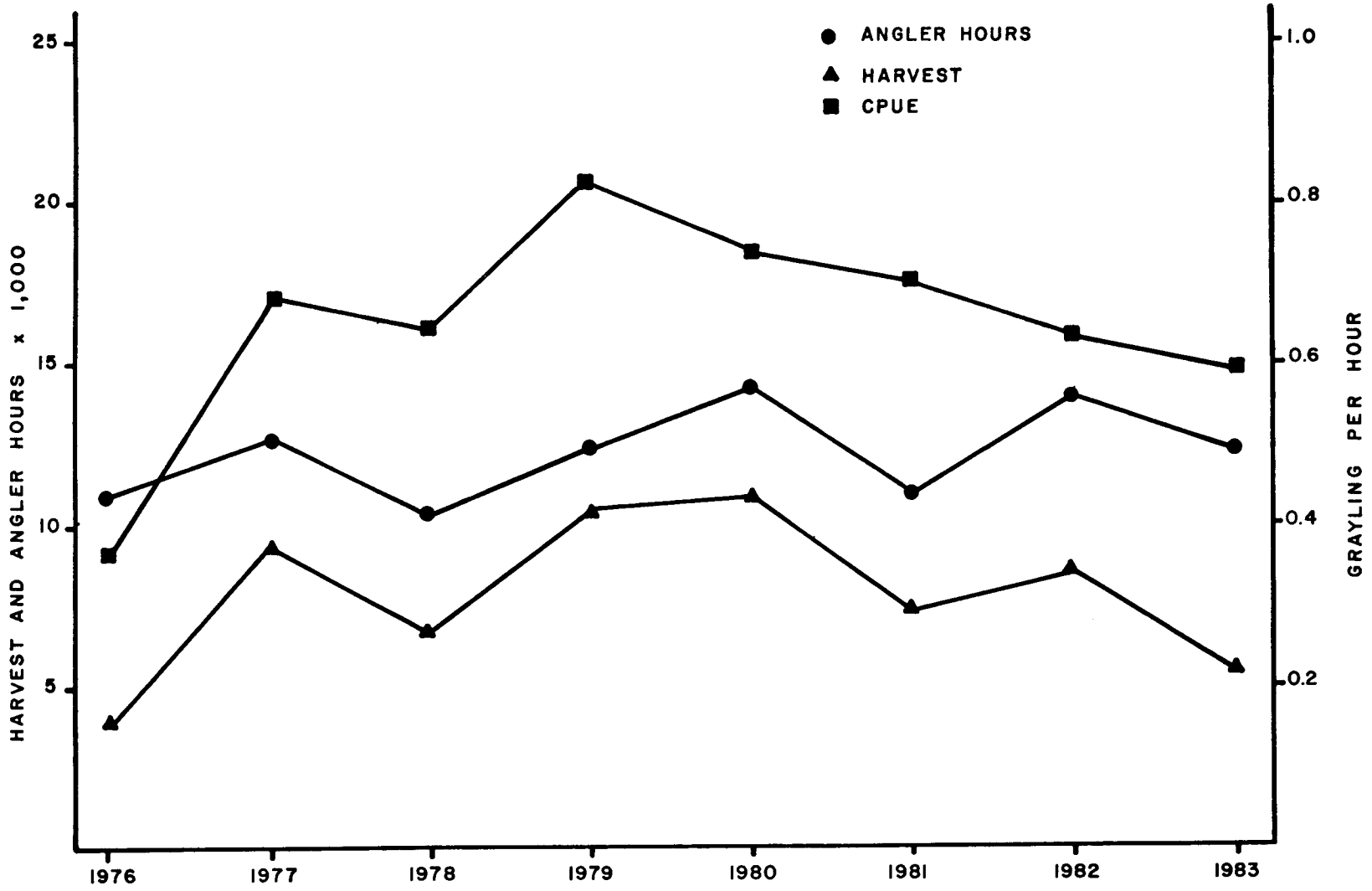

Figure 7

Harvest, angler hour, and catch rate estimates (Gr/Hr) for the upper Chena River grayling fishery June 1 - August 31, 1976-1983.

In 1983, 454 grayling larger than 200 mm were tagged, making a 4 year total of 4,519. In 1983, 118 fish were recaptured, making a total of 535 or 11.8% of the total marked. As in the past years the majority (65.3%) of the recaptures were caught in the same section as marked, showing no apparent movement. Of the 39 recaptures which had moved, 19 had moved upstream and 20 had moved downstream (Table 13).

The low proportion of demonstrated upstream movement (16.1% of all recaptures) tends to disprove the hypothesis of upstream migration with increasing age. However, several factors which may be affecting these results, including size of fish tagged, time of tagging, and time and method of recapture, are being investigated. In addition, other methods of evaluating, the upstream movement of grayling are under consideration and will be reported on next year.

Grayling Stock Enhancement

Need For Enhancement:

With a high average mortality rate (approx. 60%) the heavily fished stock of the Chena River is dependent on strong recruitment to the Age III and IV year classes. Low spawning success or low juvenile survival has occasionally resulted in weak year classes. A method of predicting these weak year classes (recruitment estimates) would enable biologists to improve stock structure through an enhancement program.

Enhancement Methods:

Small winter kill ponds are used successfully as summer rearing areas for juvenile grayling prior to stocking in the Delta Clearwater River. This method provides increased growth and probably improves survival over stream stocked grayling. Ridder (1981) reported average sizes of Age I pond reared fish which were nearly as large as Age II wild fish. The improved growth provided by this method could be used to bolster the numbers of fish in certain weak age classes in the Chena River.

Initial surveys aimed at implementing the pond rearing techniques were conducted on the Chena River in 1983. These surveys involved the location and evaluation of 21 small ponds and gravel pits in the area of the upper Chena River. From this group, seven pits (located at miles 32.9, 33.3, 36.3, 38.8, 43.7, 45.6, and 48.0 of the Chena Hot Spring Road) were chosen for possible grayling stocking experiments based on their ease of access, productivity, depth, winter dissolved oxygen levels, and bottom contours. In 1984, grayling fry will be stocked into some of these ponds to determine if the pond-reared fish do experience improved growth rates over wild stocks. If increased growth does occur and if the recruitment estimating methods prove to be accurate, this technique will be employed to increase the strength of weak Chena River age classes in future years.

Table 13. Movement summary of tagged grayling recaptured in the Chena River, 1983.

Month	No. Fish Tagged	No. Fish Recaptured	No. Moved Upstream	$\bar{x}$ Distance Traveled Upstream (mi)	No. Moved Downstream	$\bar{x}$ Distance Traveled Downstream (mi)	No Apparent Movement
May - June	295	29	5	10.6	13	14.9	12
July - Aug.	140	84	14	10.5	6	12.7	66
Sept. - Oct.	0	1	0	...	1	16	0

River Surveys

East Fork of the Chena River:

A 50 mi section of the East Fork of the Chena River, from above Mascot Creek to its confluence with the main Chena, was surveyed in early August of 1983. The major purpose of this survey was to radio-tag two grayling from the headwaters of the Chena River and to compare the size and age structure of the upper Chena River grayling with the grayling in the easily accessible portion of the lower river. All grayling were tagged with Floy internal anchor tags. Hallberg (1978) describes the physical characteristics of the East Fork.

The majority of the grayling sampling occurred in the twelve mi section of river above Van Curlers Bar (location of a major placer mine). In this section of river, 66 grayling were captured by hook and line. The age frequency showed a much higher proportion of older fish than found in the lower river (Table 14). In addition, the average size at each age was consistently 20-30 mm larger than found in the lower river. This indicates either slower growth in the lower Chena or removal of the faster growing fish from the lower Chena. This age frequency is similar to that found by Grabacki (1981) in the same area.

Grayling sampling on the East Fork below Van Curler's Bar was not possible due to heavy mining siltation from two placer mines in the area. Water samples were brought to the Dept. of Environmental Conservation for analyses. Above the mines, the turbidity level was 0.5 NTU and below the mines it was 95-100 NTU. The placer mining turbidity was apparent even below the confluence of the East Fork with the main Chena River.

East Fork radio tracking experiments were continuing at report time and will be reported on next year.

Upper Salcha River:

A 120 mile stretch of the Salcha River from above Dan Creek to its confluence with the Tanana River was surveyed in late June of 1983. The purpose of this survey was to compare grayling age and size structure from the lightly fished upper section (above Butte Creek) with the more heavily fished areas downstream. Shifts in age and length structure in the upper river occurring over time also were evaluated by comparison with length and age samples taken in the same area 9 years ago.

Based on observations of river conditions during the float, the upper Salcha was separated into three sections for comparison. Section I starts at river Mi 120 (near Dan Creek) and continues downstream about 10 mi to Paldo Creek. The stream in this section averaged about 60 ft wide and was quite shallow (aprox. 1 1/2 ft.) with numerous protruding boulders. The average water velocity was 3.1 ft per second in Section I. The stream gradient was moderate, dropping 22.2 ft/mi.

Table 14. Age and length composition of 67 grayling sampled by hook and line from the East Fork of the Chena River, 1983.

Fork Length mm	Age									
	I	II	III	IV	V	VI	VII	VIII	IX	X
120-129										
180-189			1							
190-199			...							
200-209			1							
210-219				1						
220-229				...						
230-239				...						
240-249				3						
250-259				1	1					
260-269					2					
270-279					6		1			
280-289					3	1	...			
290-299					1	2	...			
300-309						3	...			
310-319						4	...			
320-329						9	...			
330-339						...	2			
340-349						...	3	2		
350-359						1	2	2		
360-369							...	1		
370-379							1	1	1	1
380-389							1	1	1	
390-399								2	3	
400-+								1	1	
Number	0	0	2	5	13	20	10	10	6	1
Age frequency %	...	...	3.0	7.6	19.7	28.8	15.2	15.1	9.1	1.5
$\bar{x}$ fork length (mm)	0	0	195	241	272	316	345	372	391	373

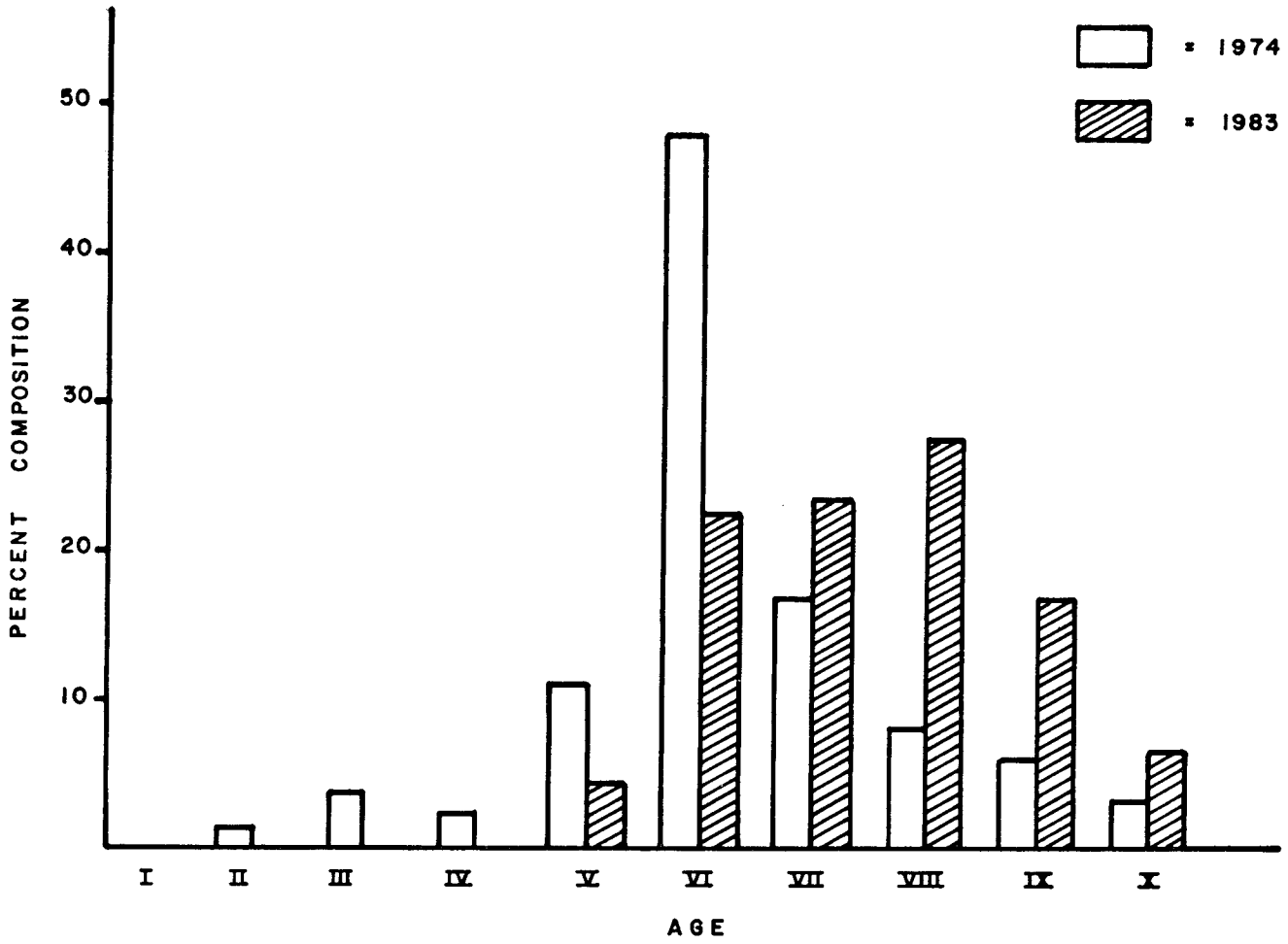

Figure 8
Percent age composition of grayling in the Salcha River above Butte Creek in 1974 and 1983.

Section II continues downstream 43 miles to the confluence of the North Fork. Numerous small streams entering the river increase the average width to approximately 110 ft and the average depth to about 4 ft. The stream gradient drops approximately 20 ft-per-mi and the average velocity was 3.2 ft-per-second.

Section III continues downstream 22 mi to Butte Creek. After the confluence of the North Fork, the river width increased to approximately 225 ft and the average depth to 7 ft. The average velocity slows to 2.9 ft/sec and the river dropped approximately 9.7 ft-per-mi.

Below Butte Creek, the Salcha River continues downstream approximately 50 miles to its confluence with the Tanana River. In this section, the river is generally confined to a single channel with a few braided areas. The water velocity slows to 2.5 ft-per-second. The stream gradient decreases to an average drop of 6 ft-per-mi. There are a large number of private cabins, and it is here that the majority of the sport fishing occurs.

Grayling were sampled by hook and line throughout the float. In Section I (above Paldo Creek), 32 grayling were sampled with an average length of 359.1 mm. In 1974, 36 grayling sampled by hook and line had a average length of 328.2 mm. In Section II, 71 grayling were sampled with an average length of 333.3 mm. In 1974, 111 grayling had an average length of 320.5 mm. In section III in 1983, 26 grayling were sampled with an average length of 314.5 mm. In this section in 1974, 28 grayling had an average length of 270 mm.

It is clear from the comparison of average length that, generally, the size of grayling decrease as you move downstream. This decline was apparent in 1974 as well as in 1983. The decline in length continues below Butte Creek where the average length of the 64 grayling sampled dropped to 258.3 mm. This drop in mean length tends to support the hypothesis of the upstream migration of grayling with increasing age. This is the same situation as noted on the Chena and Goodpaster rivers. However, as in the other cases, fishing pressure occurring in the lower river could also be the cause of the lower average grayling lengths.

A comparison of the age structure between 1974 and 1983 is given in Fig. 8. It's clear that the larger mean lengths in 1983 in each upper river section are due to an increase in the percent of older fish. On the other hand, the average lengths of the older fish (above Age VI) were higher in 1974, indicating faster growth. These shifts in age and length structure probably represent normal age class and growth rate variations as well as sampling variations and seem to indicate that no major shift in the upper Salcha River age and length structure has occurred in the past 9 years.

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